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chory, Aberdeen AB31 4NY (GB).			
(74) Agents: GOODENOUGH, Nigel et al.; A.A. Thornton & Co., Northumberland House, 303-306 High Holborn, London WC1V 7LE (GB).			
(54) Title: HYDRAULIC SLIDING SIDE-DOOR SLEEVE			
(57) Abstract			
<p>The present invention relates to hydraulically operated sliding side-door sleeves for use in wellbores. The invention provides an assembly (2) comprising an outer member (4) defining a bore and an inner member (38) defining a bore. The inner member (38) is slidably located within the bore of the member (4) so as to be movable between an open position and a closed position. The assembly (2) further comprises controlling means for selectively placing the inner member (38) in the open or closed positions. The controlling means comprises a spring (46) for biasing the inner member (38) in one axial direction relative to the outer member (4), means for shifting the inner member (38) relative to the outer member (4) against the bias of the spring (46); and selectively releasable latching means for latching the inner member (38) in the shifted position. The present invention has the advantage of being readily used in both vertical and "high angle" or horizontal wellbores.</p>			

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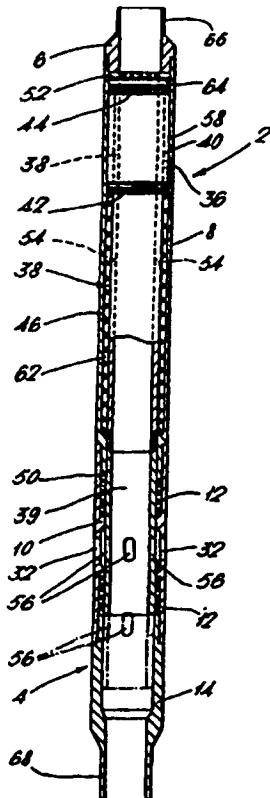
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## (54) Title: HYDRAULIC SLIDING SIDE-DOOR SLEEVE

## (57) Abstract

The present invention relates to hydraulically operated sliding side-door sleeves for use in wellbores. The invention provides an assembly (2) comprising an outer member (4) defining a bore and an inner member (38) defining a bore. The inner member (38) is slidably located within the bore of the member (4) so as to be movable between an open position and a closed position. The assembly (2) further comprises controlling means for selectively placing the inner member (38) in the open or closed positions. The controlling means comprises a spring (46) for biasing the inner member (38) in one axial direction relative to the outer member (4), means for shifting the inner member (38) relative to the outer member (4) against the bias of the spring (46); and selectively releasable latching means for latching the inner member (38) in the shifted position. The present invention has the advantage of being readily used in both vertical and "high angle" or horizontal wellbores.



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## HYDRAULIC SLIDING SIDE-DOOR SLEEVE

The present invention relates to hydraulically operated sliding side-door sleeves for use in wellbores.

Sliding side-door sleeves are commonly used in the completion tubing string of an oil or injection well to allow fluid to flow between the interior of the string and individual zones within the wellbore. The sliding side-door sleeves currently in use are moved between open and closed configurations by means of a shifting tool which is run into the tubing string on a wireline. The shifting tool is typically latched onto the sliding side-door and then manipulated from the surface by means of wireline "jars" so as to hammer the side-door open or closed. However, this operation can be problematic in "high angle" and horizontal wellbores due to the difficulty in progressing the wireline and associated tools down the tubing string. The use of a wireline and associated tools may be also hindered by the accumulation of scale and wax within the tubing string. Furthermore, the high cost of the equipment and personnel required to use wireline tools correctly can be prohibitive.

It is an object of the present invention to provide a sliding side-door sleeve assembly which may be conveniently and inexpensively moved between open and closed configurations in both vertical and "high angle" or horizontal wellbores.

The present invention provides a sliding side-door sleeve assembly for use in a wellbore, the assembly comprising an outer member defining a bore and an inner member defining a bore, the inner member being slidably located within the bore of the outer member so as to be movable between an open position, in which a hole in the inner member is arranged relative to a hole in the outer member to permit fluid communication between the bore of the inner member and the exterior of the outer member, and a closed position, in which the hole in the inner member is arranged relative to the hole in the outer member to prevent fluid communication between the bore of the inner member and the exterior of the outer member; the

assembly further comprising controlling means for selectively placing the inner member in the open or closed position, wherein the controlling means comprises a spring for biasing the inner member in one axial direction relative to the outer member, means for shifting the inner member relative to the outer member against the bias of the spring, and selectively releasable latching means for latching the inner member in the shifted position.

The shifting means of the present invention may be used to move the inner member from an open position to a closed position against the bias of the spring. The selectively releasable latching means may be then used to lock the inner member in the closed position. Since the latching means is selectively releasable, the inner member may be released from the closed position and moved to the open position by means of the spring biasing force.

Preferably, the means for shifting the inner member relative to the outer member comprises a seat for receiving a drop ball. It is preferable for the seat to be arranged so that a suitable drop ball received thereon prevents the flow of fluid through the bore of the inner member.

Furthermore, it is desirable for the selectively releasable latching means to comprise an indexing track for engagement with an indexing pin. The indexing pin preferably has a fixed axial position relative to the inner member and the indexing pin preferably has a fixed axial and angular position relative to the outer member. The indexing track may be arranged on an indexing sleeve having a cylindrical shape, the indexing sleeve being slidably mounted within the outer member and having a fixed axial position relative to the inner member. The indexing track may be provided as a groove in the surface of the indexing sleeve adjacent the outer member. It is further desirable for a bearing to be provided between an end of the spring and an end of the indexing sleeve so as to reduce the transmission of torsional forces between the spring and the indexing sleeve.

The indexing track may extend in a direction having a component in line with the direction of movement of the inner member when moving between open

and closed positions, the indexing track thereby limiting axial movement of the inner member relative to the outer member.

Furthermore, it is preferable for an end of the spring to be supported by a shoulder defined by the outer member and for a bearing to be provided between said end of the spring and the shoulder so as to reduce the transmission of torsional forces between the spring and the outer member.

The present invention has the advantage over the prior art of providing a sliding side-door sleeve assembly which may be used without difficulty in both vertical and "high angle" or horizontal wellbores. Furthermore, the present invention has the advantage of being inexpensive to manufacture and use.

An embodiment of the present invention will now be described with reference to the accompanying drawings, in which:

Figure 1 is a cross-section view of a sliding side-door sleeve assembly according to the present invention;

Figure 2 is a cross-section view of the outer barrel shown in Figure 1;

Figure 3 is a cross-section view of the inner mandrel shown in Figure 1;

Figure 4 is a cross-section view of the indexing sleeve shown in Figure 1 locked in an open position;

Figure 5 is a cross-section view of the indexing sleeve shown in Figure 1 locked in a closed position;

Figure 6 is a cross-section view of a drop ball; and

Figure 7 is an "unwrapped" view of the indexing track shown in Figures 4 and 5.

The sliding side-door sleeve assembly 2 shown in Figure 1 comprises an outer barrel 4 in which a plurality of internal components are mounted.

The outer barrel 4 comprises a top sub 6, a main body sub 8, a double box ported sub 10, chevron packing seals 12 and a bottom sub 14 (see Figure 2). The top sub 6 is threadedly engaged with an upper portion 16 of the main body sub 8 and the double box ported sub 10 is threadedly engaged with a lower portion 18 of

the main body sub 8. The end of the double box ported sub 10 distant from the main body sub 8 is threadedly engaged with the bottom sub 14. A rigid and substantially cylindrical structure is thereby defined.

An inner surface 19 of the main body sub 8 defines a bore 20 and a shoulder 22 located adjacent the lower portion 18. The main body sub 8 further incorporates an indexing pin hole 34 for receiving an indexing pin 36. An inner surface 24 of the double box ported sub 10 is provided with a pair of annular protrusions 26,28 which are spaced apart from each other to define therebetween a recess surface 30. Four port holes 32 are provided in the recess surface 30 and arranged equi-spaced about the longitudinal axis of the double box ported sub 10. In the assembled outer barrel 4, the annular protrusions 26,28 provide shoulders for locating chevron packing seals 12 adjacent the main body sub 8 and the bottom sub 14. An alternative type of seal may be used as appropriate.

The plurality of internal components mounted within the outer barrel 4 comprises an inner mandrel 38, an indexing sleeve 40, first and second ball bearing races 42,44 and a compression spring 46.

The inner mandrel 38 defines a bore 39 and incorporates an upper mandrel member 48 threadedly engaged with a lower mandrel member 50 to form a substantially cylindrical structure. The upper mandrel member 48 is provided with an annular shoulder 52 terminating the upper end thereof. A mandrel relief port 54 is also provided in the upper mandrel member 48. The lower mandrel member 50 is provided with four mandrel port holes 56 which are arranged equi-spaced about the longitudinal axis of the mandrel 38. The assembled mandrel 38 is shown in Figure 3.

The indexing sleeve 40 is cylindrical in shape and sized so as to be capable of being received within the bore 20 of the outer barrel 4. The indexing sleeve 40 is further sized to allow reception of the upper mandrel member 48 therein. The outer surface 58 of the indexing sleeve 40 is provided with an indexing track 60 in the form of a circumferential groove. The width of the indexing track 60 is sized

to receive the indexing pin 36. Figure 7 shows the "unwrapped" profile of the indexing track 60. Points A and C along the indexing track 60 correspond to a closed configuration for the sliding side-door sleeve assembly 2, and points B and D correspond to an open configuration.

The plurality of internal components are arranged within the outer barrel 4 with the upper mandrel member 48 slidably located within the bore 20 of the main body sub 8. The main body sub 8 and inner mandrel 38 form an annular space 62 in which the compression spring 46 is located. The upper end of the compression spring 46 abuts the first ball bearing race 42, upon which the indexing sleeve 40 is supported. The second ball bearing race 44 is located on the upper end of the indexing sleeve 40 between the indexing sleeve 40 and the annular shoulder 52. The indexing pin 36 is threadedly engaged with the indexing pin hole 34 so as to locate within the indexing track 60 defined in the indexing sleeve 40. An O-ring seal 64 is provided between the inner surface 19 of the main body sub 8 and the annular shoulder 52 of the inner mandrel 38.

The arrangement of the sliding side-door sleeve assembly 2 is such that the compression spring 46 tends to bias the annular shoulder 52 into abutment with the top sub 6. The axial movement of the mandrel 38 within the outer barrel 4 is limited by the movement of the indexing pin 36 within the indexing track 60. When the indexing pin 36 is located at point B or D within the indexing track 60, the inner mandrel 38 is arranged within the outer barrel 4 in an open position (as shown in Figure 1). In this position, the bore 39 defined by the inner mandrel 38 is in fluid communication with the exterior of the outer barrel 4 via the mandrel port holes 56, the port holes 32 and the annular space defined by the recess surface 30 and the lower mandrel member 50.

When the indexing pin 36 is located at point A or C within the indexing track 60, the inner mandrel 38 is arranged in a closed position within the outer barrel 4. In this position, the inner mandrel 38 is displaced axially towards the bottom sub 14 so that the mandrel port holes 56 are located below the chevron

packing seal 12 abutting the bottom sub 14. Fluid communication between the mandrel bore 39 and the exterior of the outer barrel 4 is thereby prevented. The closed position of the mandrel port holes 56 is indicated by the broken outline shown in Figure 1. In both the open and closed configurations, the chevron packaging seals 12 prevent any undesirable leakage of fluid.

The upper end portion 66 and lower end portion 68 of the sliding side-door sleeve assembly 2 is provided with a screw thread for attachment to a tubing string.

When in use, the sliding side-door sleeve assembly 2 may be arranged so that the indexing pin 36 is located at point B or D within the indexing track 60 so as to orientate the inner mandrel 38 in the open position. With the apparatus arranged in this open configuration, wellbore fluid may flow between the mandrel bore 39 and the wellbore annulus via the mandrel port holes 56 and the port holes 32 provided in the double box ported sub 10. This fluid communication may be prevented by moving the mandrel 38 into the closed position by introducing a drop ball 70 into the tubing string attached to the top sub 6. The drop ball 70 is shown in Figure 6. The ball 70 is a hollow sphere having a pressure relief port 72 for equalising the fluid pressure within the ball 70 with that in the string. The ball 70 may be manufactured from boro-silicate glass or any other suitable frangible material.

The drop ball 70 may be introduced into the string from either the surface or a point within the string, and is moved down hole through the string by the action of gravity or pump pressure. The inner diameter of the annular shoulder 52 is sized to receive the drop ball 70 and thereby form a seal preventing the passage of fluid down the string and through the mandrel bore 39 (see Figure 4). The pumping of fluid down the string increases the static pressure above the drop ball 70 and generates sufficient force to overcome the biasing of the compression spring 46. The inner mandrel 38 is thereby moved axially towards the bottom sub 14. The mandrel pressure relief port 54 assists this movement by allowing fluid located in the annular space 62 to be released into the mandrel bore 39. As the

inner mandrel 38 moves axially within the outer barrel 4, the annular shoulder 52 abuts the indexing sleeve 40 and pushes the indexing sleeve 40 axially towards the bottom sub 14. The axial movement of the indexing sleeve 40 generates relative movement between the indexing pin 36 and the indexing track 60. Where the indexing pin 36 is initially located at point B within the indexing track 60, the axial movement of the indexing sleeve 40 causes the indexing pin 36 to move to a point F within the indexing track 60 and thereby imparts a rotational movement onto the indexing sleeve 40. This rotational movement is assisted by the operation of the ball bearing races 42,44.

Once the indexing pin 36 locates at point F within the indexing track 60, further axial movement of the inner mandrel 38 towards the bottom sub 14 is not possible without the mandrel 38 first moving axially towards the top sub 6. Consequently, continued pumping of fluid down the string causes the static pressure above the drop ball 70 to increase until the force exerted is sufficient to cause the drop ball 70 to disintegrate. The disintegrated drop ball 70 is then carried through the mandrel bore 39 by the flow of fluid down the string. The axial force overcoming the compression spring 46 is removed as a result and the mandrel 38 is moved towards the top sub 6. As the mandrel 38 is moved axially towards the top sub 6 by the compression spring 46, the indexing pin 36 moves from point F to point C within the indexing track 60 (see Figure 5). Axial movement of the inner mandrel 38 is thereby limited and the annular shoulder 52 remains spaced from the top sub 6. As a consequence, the mandrel port holes 56 locate below the chevron packing seal 12 adjacent the bottom sub 14. Thus, the introduction of the drop ball 70 into the string moves the inner mandrel 38 from an open position to a closed position.

In a similar manner, the introduction of a further drop ball 70 into the string will cause the indexing pin 36 to move from point C to point G and then to point D within the indexing track 60, and thereby move the inner mandrel 38 from the closed position to the open position. The sliding side-door sleeve assembly 2 may

be cycled between open and closed configurations as many times as required.

The invention is not limited to the specific embodiment described above. Alternative arrangements and materials will be apparent to the reader skilled in the art. For example, the recess surface 30 may be provided with an alternate number of port holes 32. Similarly, an alternate number of mandrel port holes 56 may be provided in the lower mandrel member 50.

Furthermore, the main body sub 8 may be provided with more than one indexing pin 36. In such an embodiment, the indexing pins are preferably arranged equi-spaced about the longitudinal axis of the main body sub 8. Also, a shoulder may be provided on the inner surface 19 of the main body sub 8 to limit the axial movement of the indexing sleeve 40 towards the bottom sub 14. The shoulder thereby prevents the indexing pin 36 from being subjected to high loads when the predetermined crushing force is applied to the actuating ball. Similarly, the arrangement of the indexing track 60 may be such that the axial movement of the indexing sleeve 40 towards the top sub 6 is limited by the abutment of the annular shoulder 52 of the inner mandrel 38 with the top sub 6. The stresses to which the indexing pin 36 is subjected are thereby reduced. Also, an embodiment of the present invention may be arranged so that the mandrel port holes 56 locate above, rather than below, the packing seals 12 when in the closed configuration.

Furthermore, when in use, the inner mandrel 38 may be moved axially relative to the outer barrel 4 against the bias of the compression spring 46 by a wireline, or other suitable tool, as an alternative to a drop ball.

CLAIMS:

1. A sliding side-door sleeve assembly for use in a wellbore, the assembly comprising an outer member defining a bore and an inner member defining a bore, the inner member being slidably located within the bore of the outer member so as to be moveable between an open position, in which a hole in the inner member is arranged relative to a hole in the outer member to permit fluid communication between the bore of the inner member and the exterior of the outer member, and a closed position, in which the hole in the inner member is arranged relative to the hole in the outer member to prevent fluid communication between the bore of the inner member and the exterior of the outer member; the assembly further comprising controlling means for selectively placing the inner member in the open or closed position, wherein the controlling means comprises a spring for biasing the inner member in one axial direction relative to the outer member, means for shifting the inner member relative to the outer member against the bias of the spring; and selectively releasable latching means for latching the inner member in the shifted position.
2. A sliding side-door sleeve assembly as claimed in claim 1, wherein the means for shifting the inner member relative to the outer member comprises a seat for receiving a drop ball.
3. A sliding side-door sleeve assembly as claimed in claim 2, wherein the seat is arranged so that a suitable drop ball received thereon prevents the flow of fluid through the bore of the inner member.
4. A sliding side-door sleeve assembly as claimed in any of the preceding claims, wherein the selectively releasable latching means comprises at least one indexing pin and an indexing track for engagement with the or each indexing pin.

5. A sliding side-door sleeve assembly as claimed in claim 4, wherein the indexing track has a fixed axial position relative to the inner member and the or each indexing pin has a fixed axial and angular position relative to the outer member.

6. A sliding side-door sleeve assembly as claimed in claim 5, wherein the indexing track is arranged on an indexing sleeve having a cylindrical shape, the indexing sleeve being slidably mounted within the outer member and having a fixed axial position relative to the inner member.

7. A sliding side-door sleeve assembly as claimed in claim 6, wherein the indexing track is provided as a groove in the surface of the indexing sleeve adjacent the outer member.

8. A sliding side-door sleeve assembly as claimed in claim 6 or 7, wherein means is provided for reducing the transmission of torsional forces between the spring and the indexing sleeve.

9. A sliding side-door sleeve assembly as claimed in any of claims 6 to 8, wherein means is provided for reducing the transmission of torsional forces between the indexing sleeve and the inner member.

10. A sliding side-door sleeve assembly as claimed in claim 8 or 9, wherein the means for reducing the transmission of torsional forces is provided by a bearing.

11. A sliding side-door sleeve assembly as claimed in claim 8 or 9, wherein the means for reducing the transmission of torsional forces is provided by the abutment of materials having a low friction coefficient.

12. A sliding side-door sleeve assembly as claimed in any of claims 4 to 11, wherein the indexing track extends in a direction having a component in line with the direction of movement of the inner member when moving between open and closed position, the indexing track thereby limiting axial movement of the inner member relative to the outer member.

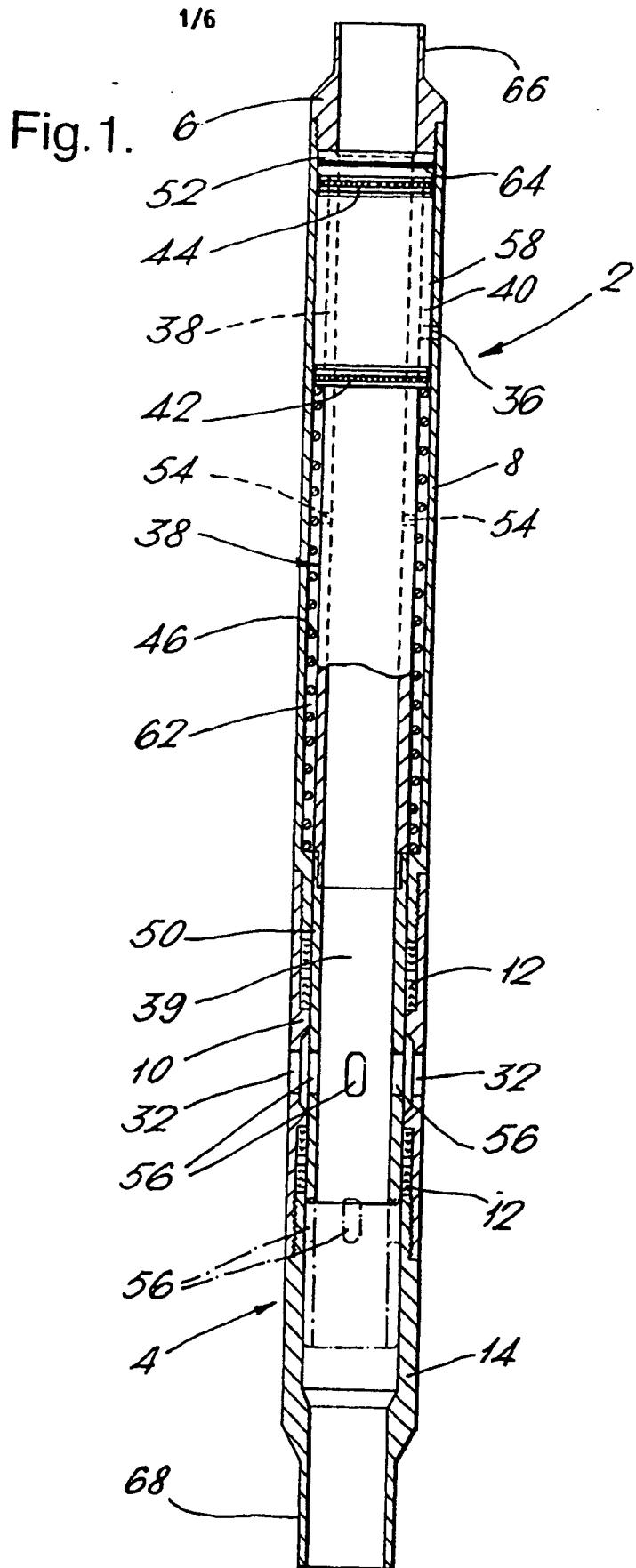


Fig.2.

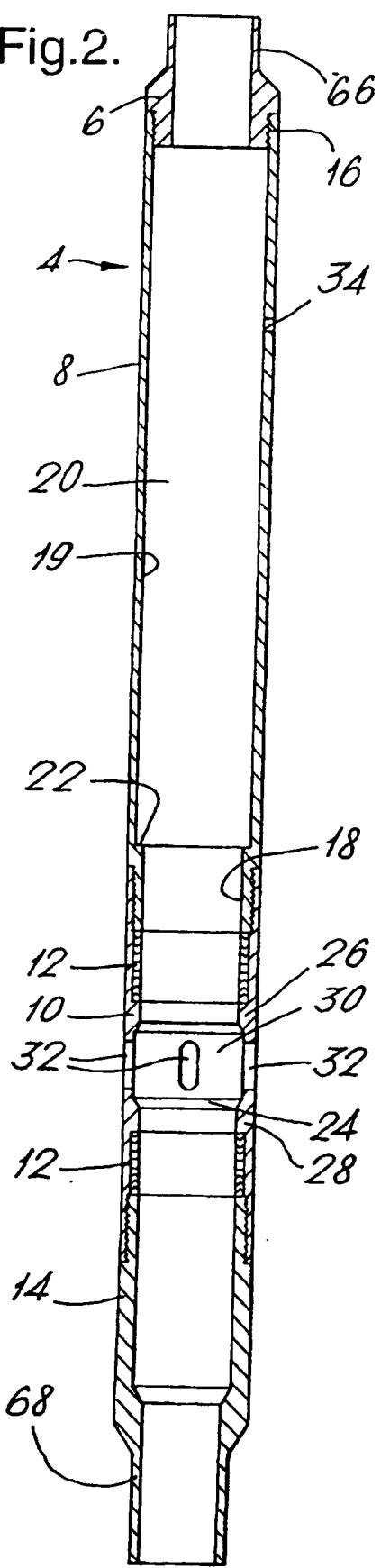


Fig.3.

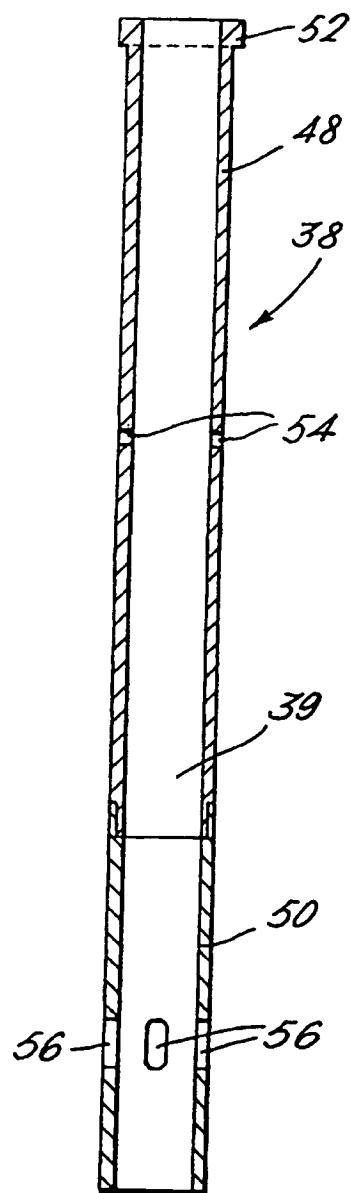


Fig.4.

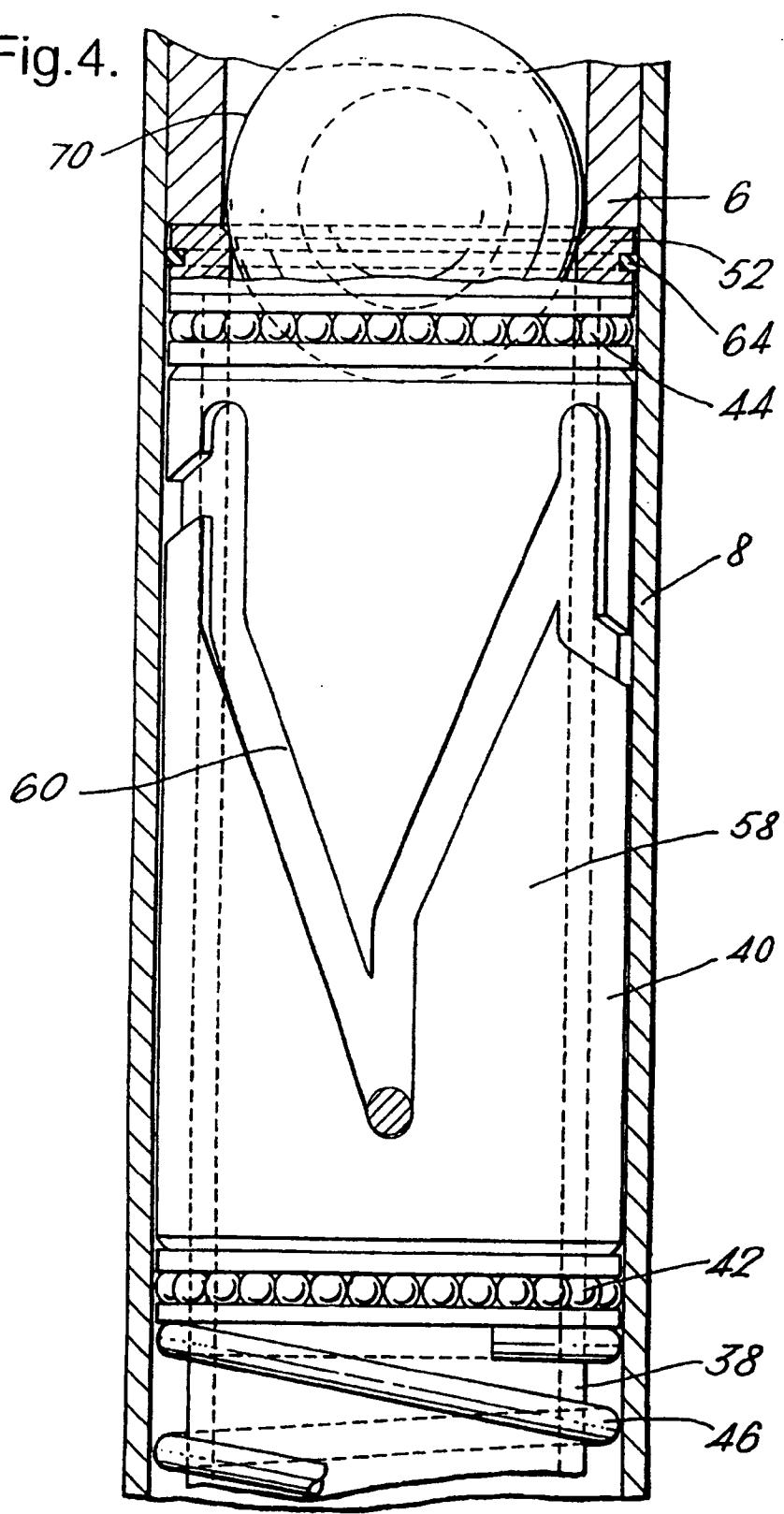
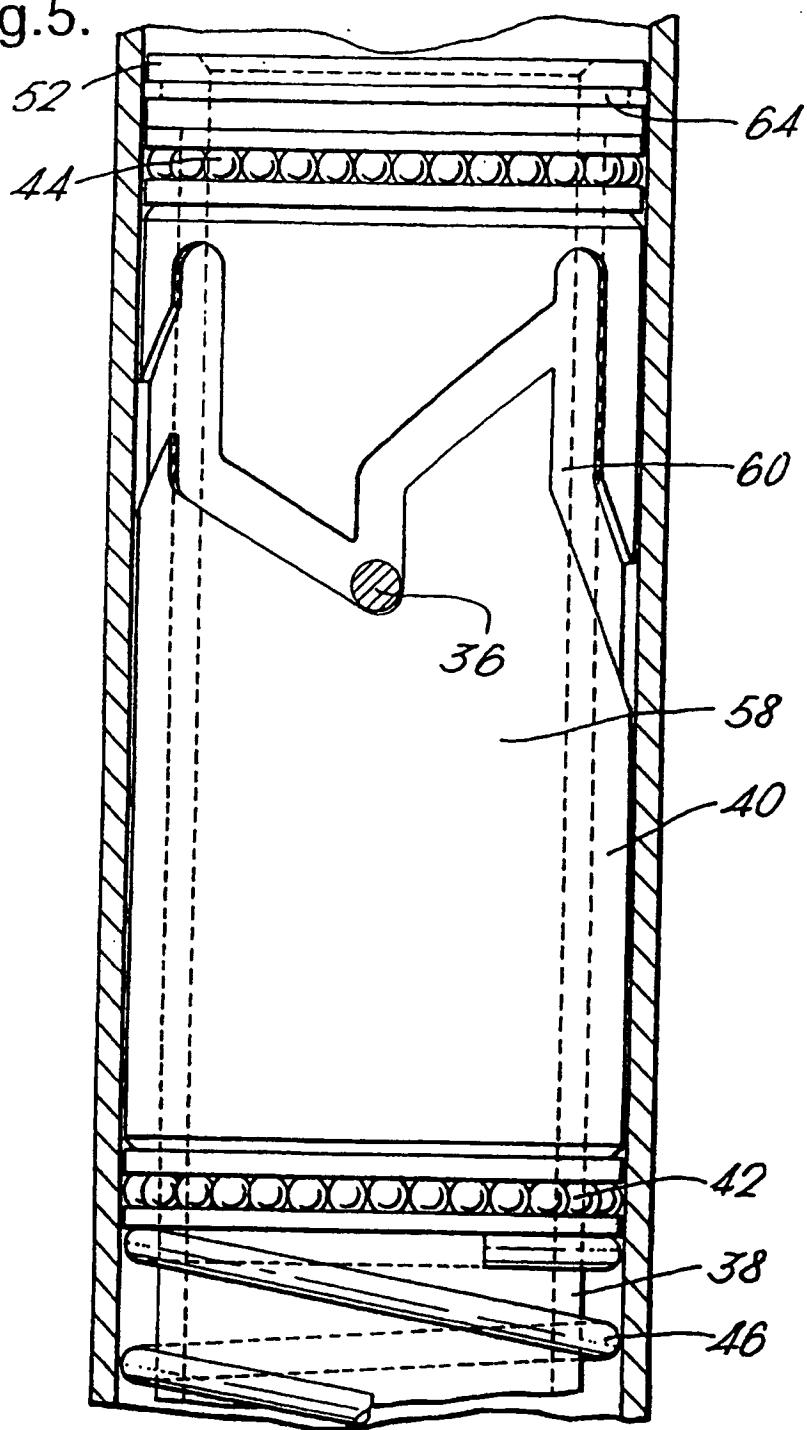


Fig.5.



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Fig.6.

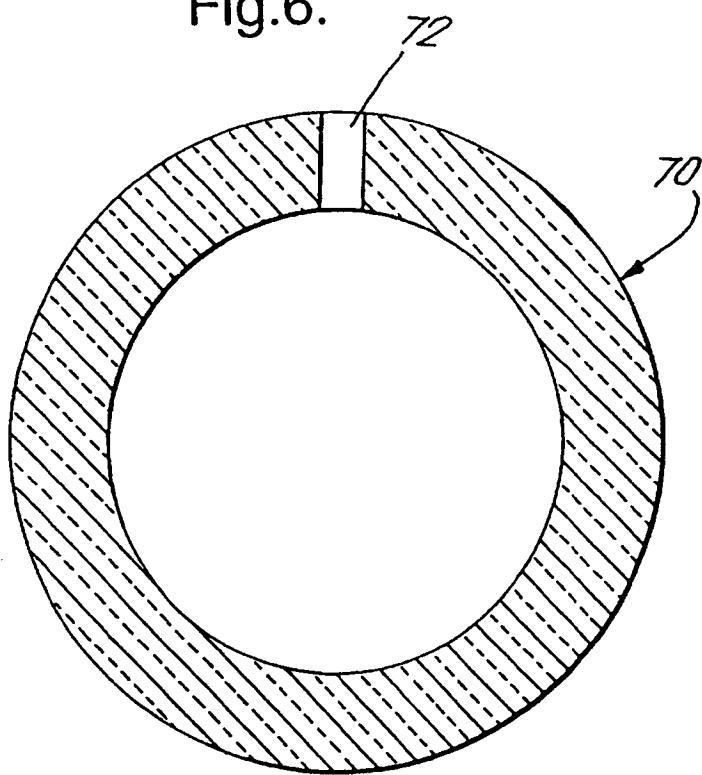
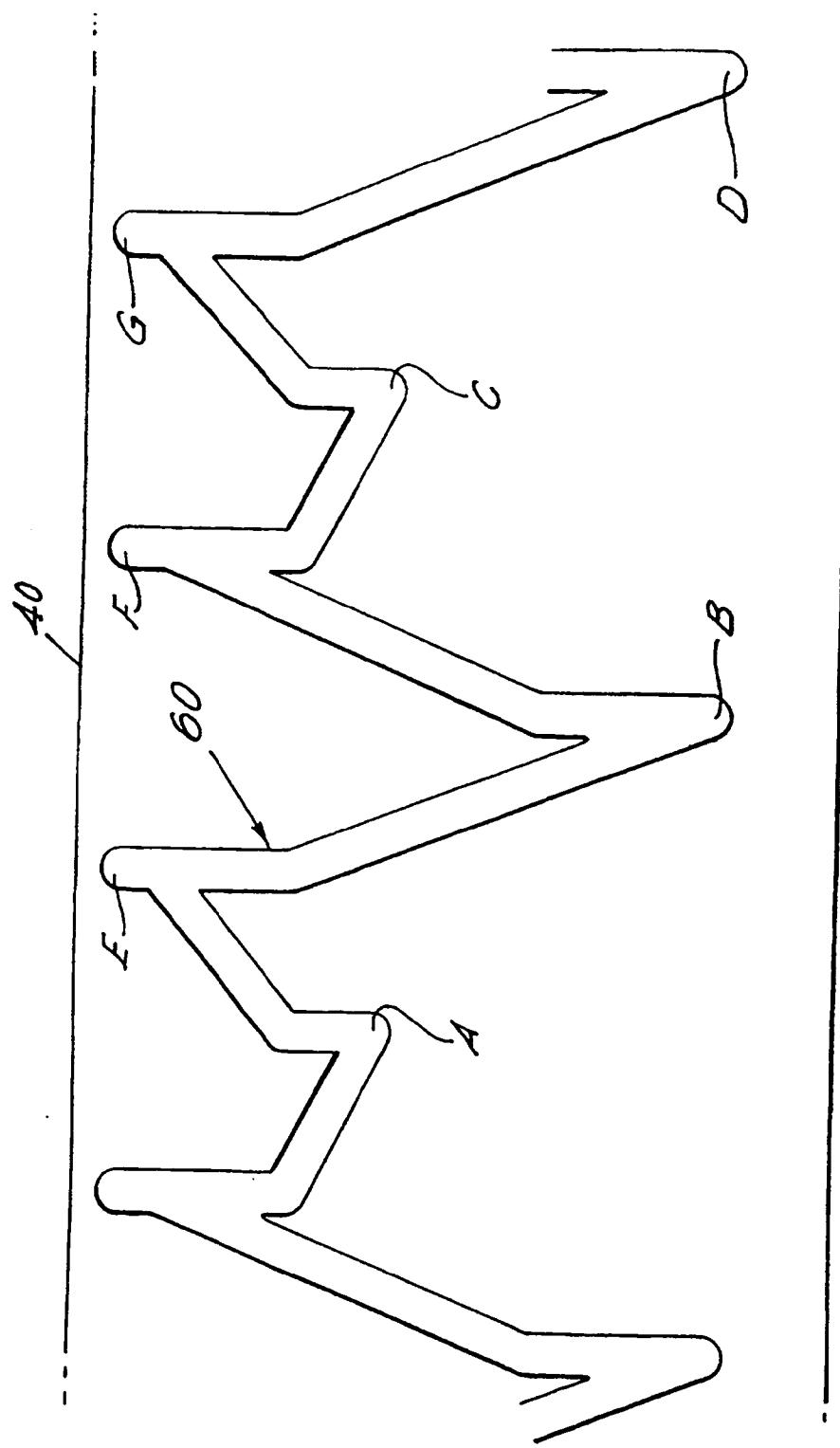


Fig.7.



# INTERNATIONAL SEARCH REPORT

Inte  
nal Application No  
**PCT/GB 97/00820**

**A. CLASSIFICATION OF SUBJECT MATTER**  
**IPC 6 E21B34/14 E21B23/00**

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)  
**IPC 6 E21B**

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5 499 687 A (LEE PAUL B) 19 March 1996 see column 1, line 59 - column 2, line 51; figures 1-3 ---	1-7,12
Y	US 3 042 116 A (F.W. SHARP) 3 July 1962 see column 1, line 49 - line 51; figures ---	1-7,12
Y	US 4 355 685 A (BECK HAROLD K) 26 October 1982 see column 1, line 1 - line 9; figures 2-4 ---	4-7,12
A	US 5 381 862 A (SZARKA DAVID D ET AL) 17 January 1995 see column 10, line 56 - line 65; figures ---	8-11
A	US 5 379 839 A (HISAW JACK) 10 January 1995 see figures 1,2 ---	8-11
	-/-	

Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

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Date of the actual completion of the international search  <b>20 June 1997</b>	Date of mailing of the international search report  <b>02.07.97</b>
Name and mailing address of the ISA  European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+ 31-70) 340-2040, Tx. 31 651 epo nl. Fax: (+ 31-70) 340-3016	Authorized officer  <b>Fonseca Fernandez, H</b>

## INTERNATIONAL SEARCH REPORT

International Application No  
PCT/GB 97/00820

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